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UGUST 5, 1940
OLUME 29, No. 16

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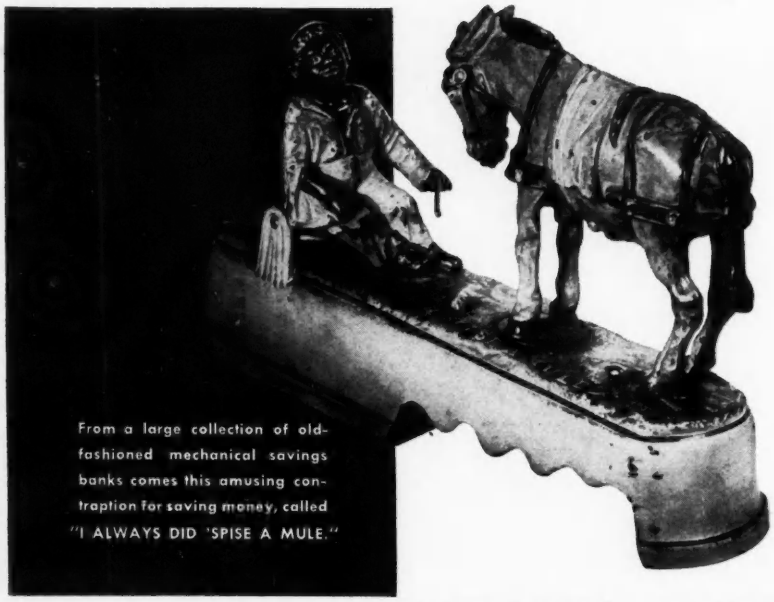

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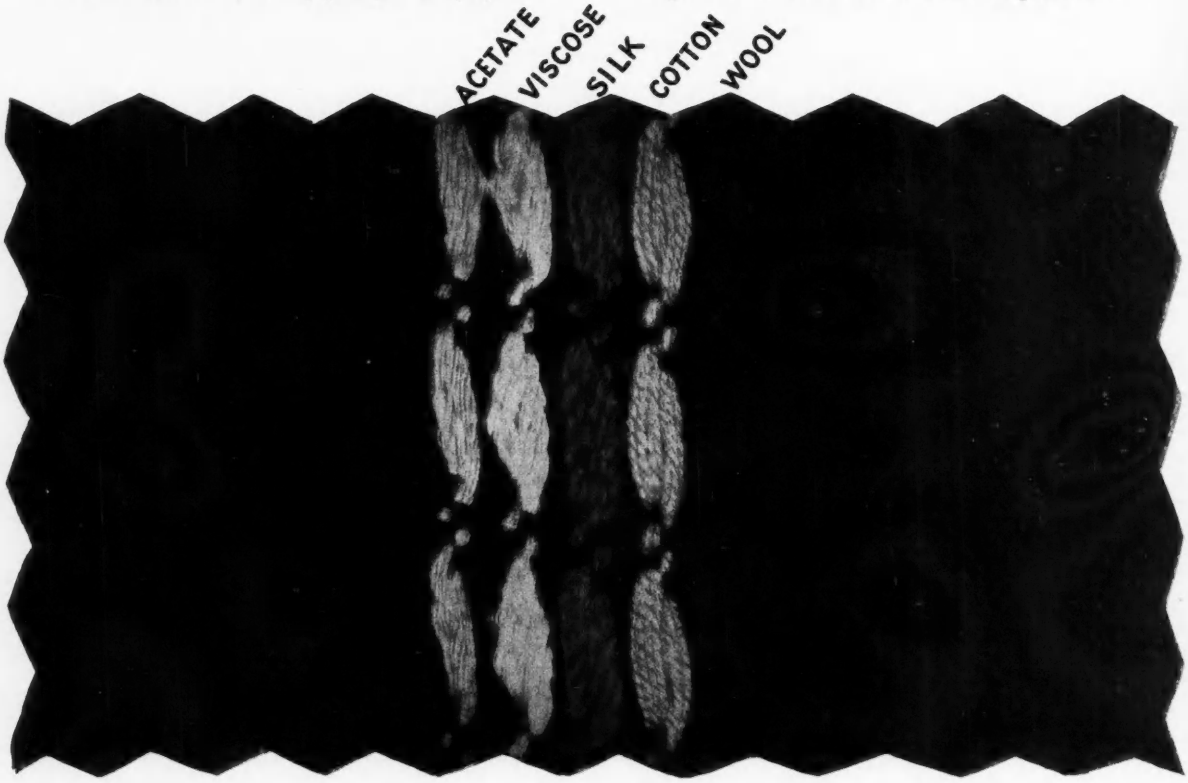

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AMERICAN
DYESTUFF REPORTER

VOLUME 29 AUGUST 5, 1940 NUMBER 16

A Simple Laboratory Method of

Studying Fulling Phenomena

GEORGE C. LE COMPTE and JOSEPH W. CREELY

WE mentioned in the first paper of this series the following simple example of wool "felting" or "fulling." If a piece of yarn is placed in a container with water and vigorously shaken, the yarn shortens in length due to fiber travel. The rate of this shrinkage can be increased many times by adding various substances to the water such as acids and wetting agents. The wool itself can be treated in order to change its rate of shrinkage. We found that by carefully controlling this laboratory process we could get results that are sufficiently reproducible to be a valuable tool in studying fulling phenomena.

We secured a quantity of fine wool yarn which had been purified by extraction with petroleum ether and finally backwashed with dilute ammonia. This yarn was 2 ply and was made of approximately 70 per cent territory, 10 per cent pulled and 20 per cent Texas wool. It was cut into lengths of about one meter and loops tied on each end. Three such pieces were placed in a three ounce cylindrical wide mouthed bottle containing 50 mls. of the fulling bath. The yarn is allowed to soak twenty minutes to allow internal stresses to be relieved before measuring its length. The length of the yarn is conveniently measured by hanging it from a small nail even with the top of a vertically supported meter stick. A small hook weighing three grams is placed on the bottom loop of the yarn and its total length read off the meter stick. The yarn is removed and folded double four times, then placed in the bottle and stoppered. The bottle is secured to a vane of an electric washer. If the test is to be made at elevated temperature water can be added up to the level of the top of the bottle and its temperature adjusted. For most work a temperature of 20° C. is suitable. In either case the washer is started and the bottle shaken for a measured length of time. The yarn is removed and carefully untangled and again measured. The percentage of shrinkage based on the initial length can then be calculated.

A vane of the washer used in this work oscillated through a third of a revolution. Its period was slightly more than one second. The radius of the arc traversed by a bottle was 12.5 centimeters. The machine used had three vanes and could accommodate six bottles, hence 18 separate lengths of yarn could be used at one shaking.

EFFECT OF TIME OF SHAKING

The following data represent the mean of shrinkages on six pieces of yarn. The samples were shaken three in a bottle as previously described and lengths measured at stated time intervals of shaking. The first run was made in 1 per cent sulfuric acid, the second in 1 per cent sodium carbonate, the third in a 1 per cent sulfuric acid solution containing 0.5 per cent commercial wetting agent*, the fourth in a 1 per cent sulfuric acid solution containing 0.1 per cent of a condensation product of triethanolamine and oleic acid** and the fifth in plain water. The temperature was 20° C. in each case. The data of Table 1 include

TABLE 1
First Run—1 Per Cent Sulfuric Acid

Time, Minutes t	*Length Cms.* L	*Shrinkage* s	$\frac{1}{t} \log (1\text{-}s)$	
0	95.3	0.000	—	
15	84.7	0.110	—0.00337	
30	74.4	0.220	—0.00360	
45	65.6	0.311	—0.00360	
60	58.5	0.386	—0.00353	Ave.
75	51.4	0.460	—0.00356	—0.00356
90	45.9	0.519	—0.00353	
105	40.5	0.575	—0.00354	
120	38.1	0.600	—0.00332	
135	36.0	0.622	—0.00313	
150	33.7	0.646	—0.00300	
165	30.8	0.677	—0.00297	
180	28.5	0.701	—0.00292	
195	27.2	0.715	—0.00279	

*This product contains 80 per cent water and about 20 per cent C_{17} H_{33} CONH C_2 H_4 SO_3 Na.

**Triethanolamine and oleic acid were mixed in equimolecular proportions and heated to 180-200° C. for 20 minutes and cooled. The condensation product formed is dispersable in acid solution and is a powerful foaming and wetting agent. Solutions of it in 1 per cent sulfuric acid increase rate of fulling.

TABLE 1—CONT.

Second Run—1 Per Cent Sodium Carbonate

Time, Minutes t	Length Cms. L	Shrinkage s	$\frac{1}{t}$ log (1-s)	
0	92.8	0.000	—	
10	88.5	0.045	—0.00200	
20	83.3	0.101	—0.00231	
40	76.7	0.173	—0.00206	Ave.
60	70.8	0.237	—0.00196	—0.00207
90	61.1	0.341	—0.00202	
150	51.9	0.440	—0.00168	
210	45.5	0.509	—0.00147	

Third Run—1 Per Cent Sulfuric Acid and 0.5 Per Cent Commercial Wetting Agent

Time, Minutes t	Length Cms. L	Shrinkage s	$\frac{1}{t}$ log (1-s)	
0	90.6	0.000	—	
10	81.3	0.102	—0.00467	
20	71.7	0.208	—0.00507	
30	64.0	0.293	—0.00502	
40	56.4	0.377	—0.00513	Ave.
50	50.7	0.440	—0.00504	—0.00499
60	44.5	0.509	—0.00515	
75	38.0	0.580	—0.00502	
90	33.5	0.630	—0.00480	
120	28.5	0.685	—0.00418	
210	24.8	0.726	—0.00268	

time of shaking (t), length of yarn (L), shrinkage based on the initial length of the yarn and expressed as a decimal fraction of it (s). The fourth column lists the calculated quantity

$\frac{1}{t}$ log (1-s). It will be noticed that this is fairly constant up to a shrinkage of 57.5 per cent in the first, 34.1 per cent in the second, 63.0 per cent in the third and 41.6 per cent in the fourth run.

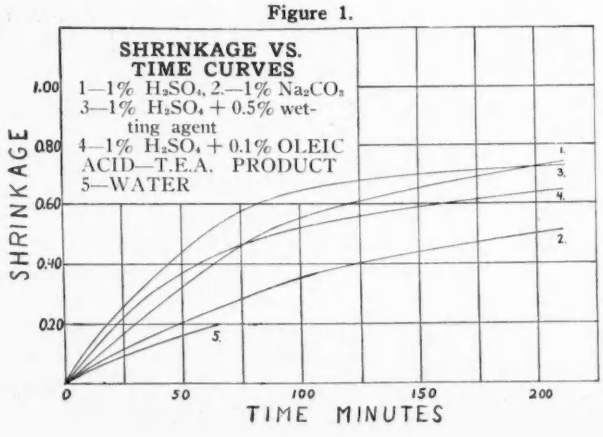
Plots of these data in Figure 1 show that the first portion of the curve up to about 20 per cent shrinkage might be expressed as a linear equation between s and t. The curve

$$\log (1-s) = Kt \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

fits the data over a greater range in shrinkage however. The portion of the curve beyond the highest value of s satisfying equation (1) is best fitted by a straight line. We are more interested in the first portion of the curve as we can use this easily in comparing different yarn treatments and evaluating them.

In Table 2 we compare the calculated and observed values

Figure 1.



Fourth Run—1 Per Cent Sulfuric Acid and 0.1 Per Cent Triethanolamine—Oleic Acid Condensation Product

Time, Minutes t	Length Cms. L	Shrinkage s	$\frac{1}{t}$ log (1-s)	
0	93.2	0.000	—	
10	84.4	0.095	—0.00434	
20	76.5	0.179	—0.00428	
30	68.6	0.264	—0.00444	Ave.
40	63.0	0.324	—0.00426	—0.00422
50	58.2	0.375	—0.00409	
60	54.4	0.416	—0.00389	
75	50.0	0.462	—0.00360	
90	45.8	0.508	—0.00343	
120	41.8	0.552	—0.00291	
210	32.4	0.652	—0.00218	

Fifth Run—Water

Time, Minutes t	Length Cms. L	Shrinkage s	$\frac{1}{t}$ log (1-s)	
0	89.2	0.000	—	
5	87.2	0.022	—0.00193	
10	86.0	0.036	—0.00159	
15	83.8	0.061	—0.00182	
20	81.6	0.085	—0.00193	
25	79.9	0.104	—0.00191	
30	78.6	0.119	—0.00184	
45	75.9	0.149	—0.00156	
60	73.4	0.177	—0.00141	
			Ave. —0.00175	

TABLE 2

First Run—1 Per Cent Sulfuric Acid

Time, Minutes	Shrinkage Calc.	Shrinkage Observed
15	0.116	0.110
30	0.218	0.220
45	0.319	0.311
60	0.388	0.386
75	0.459	0.460
90	0.522	0.519
105	0.577	0.575

TABLE 2—CONT.

Second Run—1 Per Cent Sodium Carbonate

Time, Minutes	*Shrinkage*	
	Calc.	*Observed*
10	0.046	0.045
20	0.091	0.101
40	0.174	0.173
60	0.249	0.237
90	0.348	0.341

Third Run—1 Per Cent Sulfuric Acid and 0.5 Per Cent Commercial Wetting Agent

Time, Minutes	*Shrinkage*	
	Calc.	*Observed*
10	0.109	0.102
20	0.205	0.208
30	0.292	0.293
40	0.368	0.377
50	0.437	0.440
60	0.498	0.509
75	0.577	0.580
90	0.644	0.630

Fourth Run—1 Per Cent Sulfuric Acid and 0.1 Per Cent Triethanolamine—Oleic Acid Condensation Product

Time, Minutes	*Shrinkage*	
	Calc.	*Observed*
10	0.093	0.095
20	0.177	0.179
30	0.253	0.264
40	0.322	0.324
50	0.385	0.375
60	0.441	0.416

Fifth Run—Water

Time, Minutes	*Shrinkage*	
	Calc.	*Observed*
5	0.020	0.022
10	0.040	0.036
15	0.059	0.061
20	0.077	0.085
25	0.096	0.104
30	0.114	0.119
45	0.166	0.149
60	0.215	0.177

of shrinkage (s). The calculated values were obtained from equation (1) by substitution of the average values of K or $\frac{1}{t}\log(1\text{-}s)$ listed in Table 1. The agreement is good over the ranges selected.

Equation (1) might be obtained by integrating the differential equation

$$\frac{1}{L}\frac{dL}{dt} = K_s = 2.303\ K \quad \ldots\ldots\ldots\ldots\ldots (2)$$

This states that the rate of change of length of the yarn, expressed as a fraction of instantaneous length of yarn, per unit time is constant.

Assuming that equation (1) holds for yarns and that the increase in thickness of yarn caused by its shrinkage in length has no effect on its rate of shrinkage if woven in a cloth we can show that if S_A is the shrinkage of cloth as a fraction of the original area in time t:

$$1\text{-}S_A = (1\text{-}s)^2,$$

$$\log\ (1\text{-}S_A)^{1/2} = Kt \text{ or } \frac{1}{2}\log\ (1\text{-}S_A) = Kt$$

or

$$\log\ (1\text{-}S_A) = K_1 t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where K_1 is a constant equal in value to $2K$. We can test equation (3) with the data of Speakman, Stott and Chang[2] (Table III and Table XII). Values of $\frac{1}{t}\log\ (1\text{-}S_A)$ are worked out for cloth from these data in Tables 3 (a) and

TABLE 3 (a)

Calculated from Data of Speakman, Stott and Chang[2] (Table III)

pH	*Time, Hours*	S_A	$\frac{1}{t}\log\ (1-S_A)$
0.50	1	0.191	—0.0921
0.50	2	0.328	—0.0863
0.50	3	0.429	—0.0811
0.50	4	0.481	—0.0712
0.50	5	0.533	—0.0661
1.06	1	0.169	—0.0804
1.06	2	0.276	—0.0701
1.06	3	0.371	—0.0671
1.06	4	0.458	—0.0665
1.06	5	0.507	—0.0614
1.66	1	0.151	—0.0711
1.66	2	0.247	—0.0616
1.66	3	0.339	—0.0599
1.66	4	0.414	—0.0580
1.66	5	0.458	—0.0532
2.99	1	0.114	—0.0526
2.99	2	0.197	—0.0476
2.99	3	0.260	—0.0436
2.99	4	0.321	—0.0420
2.99	5	0.368	—0.0399
3.93	1	0.090	—0.0410
3.93	2	0.164	—0.0389
3.93	3	0.250	—0.0416
3.93	4	0.286	—0.0388
3.93	5	0.335	—0.0354

TABLE 3 (a)—CONT.

pH	*Time, Hours*	S_A	$\frac{1}{t} \log (1 - S_A)$
8.29	1	0.094	—0.0429
8.29	2	0.160	—0.0378
8.29	3	0.233	—0.0384
8.29	4	0.288	—0.0369
8.29	5	0.336	—0.0356
8.57	1	0.102	—0.0467
8.57	2	0.176	—0.0420
8.57	3	0.231	—0.0380
8.57	4	0.279	—0.0355
8.57	5	0.339	—0.0360
8.97	1	0.110	—0.0506
8.97	2	0.209	—0.0509
8.97	3	0.284	—0.0484
8.97	4	0.354	—0.0475
8.97	5	0.402	—0.0447
9.92	1	0.171	—0.0814
9.92	2	0.326	—0.0857
9.92	3	0.408	—0.0759
9.92	4	0.470	—0.0689
9.92	5	0.502	—0.0606
10.30	1	0.134	—0.0625
10.30	2	0.229	—0.0565
10.30	3	0.319	—0.0556
10.30	4	0.391	—0.0539
10.30	5	0.429	—0.0487

(b). The approximate constancy of this quantity can be observed here for a wide variety of fulling conditions on woolen cloth.

In Table 4 we include data from Schofield[1] in which he has shown an exponential relation to hold good in the case of the manufacture of felts. The equation for this is not the same as in the case of cloth. Schofield found an equation of the form

$$T = At^{-B} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

to hold. In some experiments he found A = 3.88 and B = 0.033. A and B are positive constants dependent on experimental conditions. T is the thickness of the felt in centimeters and t is the time in minutes. Schofield found no maximum in felting at 45° C. in contrast to Speakman, Stott and Chang[2]. Instead he found a steady increase with temperature up to 85° C. He claims that previous workers who have studied shrinkages of cloth in a fulling mill were not studying felting at all but merely shrinkage in cloth area which is a preliminary to the real felting. What he says is true if you accept his definition for felting. Shrinkage in cloth area is important and we believe that our method of measuring yarn shrinkages gives some indication as to how cloth areas will shrink under similar treatment.

TABLE 3 (b)
Calculated from Data of Speakman, Stott and Chang[2] (Table XII)

Temperature C.	*Time Hours*	S_A	$\frac{1}{t} \log (1 - S_A)$
37.1	0.5	0.152	—0.143
37.1	1.0	0.412	—0.231
37.1	1.5	0.512	—0.208
37.1	2.0	0.569	—0.183
37.1	2.5	0.601	—0.160
42.0	0.5	0.186	—0.179
42.0	1.0	0.442	—0.253
42.0	1.5	0.542	—0.226
42.0	2.0	0.593	—0.195
47.6	0.5	0.167	—0.159
47.6	1.0	0.420	—0.237
47.6	1.5	0.533	—0.220
47.6	2.0	0.594	—0.196
47.6	2.5	0.615	—0.166
52.4	0.5	0.152	—0.143
52.4	1.0	0.338	—0.179
52.4	1.5	0.494	—0.197
52.4	2.0	0.565	—0.181
52.4	2.5	0.606	—0.162

TABLE 4
Data of Schofield[1]

Time Minutes t	*Thickness Cms. T*	*Log t*	*Log T*	*Log A (calc.)*
0	4.43	....	0.646	....
0.25	4.02	1.398	0.604	0.624
0.75	3.80	1.875	0.580	0.584
1.5	3.75	0.170	0.574	0.580
3.0	3.65	0.477	0.562	0.578
6.0	3.57	0.778	0.553	0.579
11.0	3.52	1.041	0.547	0.582
21.0	3.42	1.322	0.534	0.588
36.0	3.35	1.556	0.525	0.577

DISCUSSION OF THE PROCEDURE

The procedure which we found to be most suitable for studying rate of yarn shrinkage is as follows: Measure the length of yarn after 20 minutes soaking in the fulling bath, then shake for 10 minutes and measure the length of yarn. Repeat and measure the length after another 10 minutes of shaking. Use 6 lengths of yarn for each sample and determine the average length before shaking (L_0), after shaking 10 minutes (L_{10}) and after shaking a total of 20 minutes (L_{20}). Calculate S_{10} and S_{20} from the relations.

$$S_{10} = \frac{L_0 - L_{10}}{L_0}, \quad S_{20} = \frac{L_{10} - L_{20}}{L_0} \quad \ldots\ldots (5)$$

(Continued on page 408)

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• CALENDAR • OF COMING EVENTS

Meeting, Southeastern Section, Civic Room, Hotel Ralston, Columbus, Ga., September 28th, 1940. Speaker: W. D. Anderson, president of Bibb Manufacturing Co., Macon, Ga. There will also be a technical paper, the subject of which will be announced later.

Annual Meeting and Convention, auspices New York Section. October 18th and 19th, 1940, Hotel Commodore, New York City.

Meeting, Piedmont Section, Carolina Hotel, Pinehurst, N. C., November 1 and 2, 1940.

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Standardization of Color Names*

The ISCC-NBS Method[1]

DOROTHY NICKERSON**

THE science of colorimetry has made great strides during the past 15 years. Two important contributing factors have been (1) the international adoption in 1931 of certain standards for illuminants, for methods of illuminating and viewing colors, for a standard observer, and certain conventions for expressing color data; and (2) the development of instruments for rapid and accurate color measurement. There is still a long way to go, but colorimetry is fortunate in that its workers not only believe in cooperative effort but through concerted effort actually have been able to develop active programs that have resulted in greater progress than would have been possible otherwise.

In order to promote uniformity of nomenclature in the presentation of textile color data, the Research Committee of the A.A.T.C.C. has endorsed the method of designating colors (known as the ISCC-NBS Method) developed for the Inter-Society Color Council at the National Bureau of Standards, and recommended that the description of this method prepared by the Secretary of the Inter-Society Color Council, be printed in the proceedings of the A.A.T.C.C.

During general progress in this field, consideration has been given to the problem of developing a system of color names that would be based on a foundation firm enough to satisfy the color scientist, general enough to be acceptable and useful to the scientist, artist, and industrialist, and sufficiently commonplace to be understood, at least in a general way, by the whole public.

Because of its connection with problems which arise in the work of standardization of agricultural products, the color laboratory of this Service has cooperated with other color laboratories in the solution of this problem, the work having been done under the direction of committees of the Inter-Society Color Council, of which the American Society for Testing Materials is one of the eleven national associations that are member bodies. The problem of developing color names was presented to the Inter-Society Color Council at its first meeting in 1931 by the Revision Committee of the United States Pharmacopoeia. The report in 1933 of the Council's Committee on Measurement and Specification gave the basis which has been followed since then. Setting boundaries for the color names was the greatest problem, the work being done at the National Bureau of Standards. The work would have been impossible without the aid given by the American Pharmaceutical Association and the U. S. Pharmacopoeial Revision Committee who for this purpose jointly supported a research associateship at the National Bureau of Standards. A report of this work, with 34 charts of name boundaries[2] was published in September 1939 by the National Bureau of Standards. The method is the result of the joint work of all important standardization groups interested in color, for the letter ballot of the Inter-Society Color Council regarding adoption of this method showed that 26 out of 27 votes received (33 possible) were for adoption. Each association has three voting delegates in the Council, which accounts for the possible 33, and except for one association vote marked "not voting" there were at least two affirmative votes from each association in the Council. There were no negative votes.

The method adopted is simple in principle. The terms light, medium, and dark designate increasing degrees of darkness, the adverb "very" is added to extend the lightness scale to "very light" and "very dark." The adjectives weak, medium, strong, vivid designate increasing degrees of chroma. In order that unwieldy adjective combinations shall not be required, the following terms may be substituted for certain descriptions:

pale as a substitute for light, weak
brilliant as a substitute for light, strong
moderate as a substitute for medium, medium
dusky as a substitute for dark, weak
deep as a substitute for dark, strong

The relationship of these adjective modifiers is shown in Figure 1. These terms are used to modify the following hue or limited hue range names: pink, red, orange,

*Address, Committee D-13, American Society for Testing Materials, Charlotte, N. C., March 13-15, 1940.
**Color Technologist, Agricultural Marketing Service, and Secretary, Inter-Society Color Council.
[1]Initials are for Inter-Society Color Council-National Bureau of Standards.
[2]Dean B. Judd and Kenneth L. Kelly, Method of Designating Colors, NBS J. Research, *23*, 355, Sept. (1939); RP 1239. Copies of report obtainable from Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.
[3]Dorothy Nickerson, Use of ICI Tristimulus Values in Disk Colorimetry. Mimeographed Preliminary Report, 1938. United States Department of Agriculture.

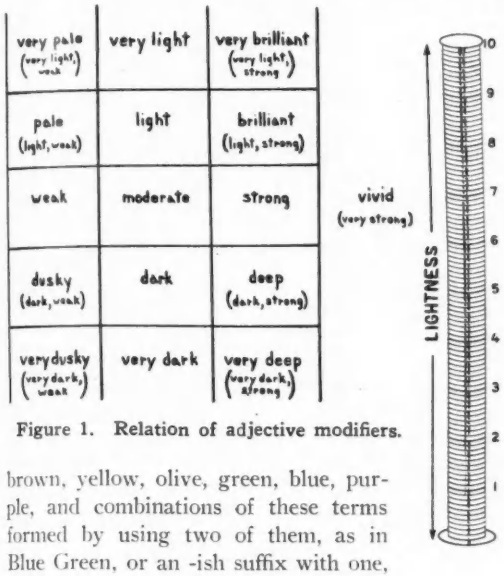


Figure 1. Relation of adjective modifiers.

brown, yellow, olive, green, blue, purple, and combinations of these terms formed by using two of them, as in Blue Green, or an -ish suffix with one, as in purplish Pink. For the neutral series the terms, white, gray, and black are used.

Certain of the hue names cover all lightnesses and chromas, as in the case of Green. But certain other hue names cover only a limited range of lightnesses and chromas, as the Pinks which are really very light Reds, and the Olives which are actually dark Yellows. But common usage is so strong in regard to such terms that the ISCC-NBS[1] method has taken them into consideration, and has applied different names to limited ranges of lightnesses and chromas of a single hue. To constant hues in certain Yellow-Reds, the name Brown is given to the dark group of colors, the term Orange to those that are light and medium-to-strong in chroma, and the term Orange-Pink to those for light and weak Yellow-Reds. Each of the terms, Brown, Orange, and Orange-Pink is then divided into several designations by the use of appropriate modifiers selected from those shown in Figure 1.

The relationship of these names can be explained most easily by reference to what is known as a color solid. Because the three color attributes of any surface color may be represented in a three-dimensional solid, it is often called a surface-color solid. The dimensions of this solid are hue, lightness, and chroma, which are diagrammatically represented in Figure 2. The scale of lightness starts at the bottom of the scale, and is measured in lightness units from 0 at black, to 10 (or 100) at white. Hue is represented by an angle about the black-white axis, giving a closed series of red, yellow, green, blue, and purple, back to red, including all intermediate hues in their proper positions. Chroma is represented by distance from the black-white axis on a radius extending to the boundary of the solid, the grayest colors being near the center of the solid, the vivid colors at the surface of the solid. The numbers on the diagrams represent the Munsell notation.

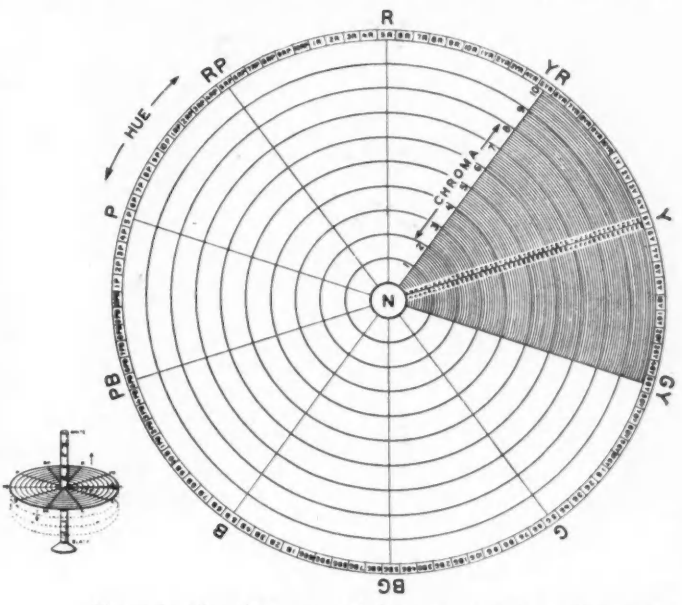


Figure 2. Hue, lightness, and chroma in their three dimensional relationship. The letters and numbers represent the Munsell notation.

The color designations of the ISCC-NBS system therefore define a block in the surface-color solid, and the complete system provides for 312 such blocks. This number is quite sufficient for naming colors from memory, but it means that each block contains a number of distinguishable colors.

The boundaries of each name designation are given in 34 charts included in the Judd-Kelly report[2]. For simplicity and ease of reference the limits are reported at the present time in terms of the Munsell color notation. It may be desirable ultimately to supplement this practical definition of limits for each color designation by giving equivalent definitions in terms of the 1931 internationally adopted coordinate system, since it does not depend upon a material set of standards, as does the Munsell system. However, interpolation curves made available by the laboratories of the Agricultural Marketing Service[3] already permit a fairly reliable transfer from Munsell notation to ICI specification, and it is expected that conversion tables of the colors in the Maerz and Paul Dictionary of Color will soon be available in Munsell notation. This will enable the use of the standard ISCC-NBS color name by reference to the ICI, Maerz and Paul Dictionary, or the Munsell system directly, through the use of published conversion tables.

The simplest equipment for using the ISCC-NBS names with a reasonable assurance of accuracy is a good light, a set of pocket-sized Munsell charts, and a mask made of a neutral gray (near medium lightness unless there is a special reason for selecting one lighter or darker). In

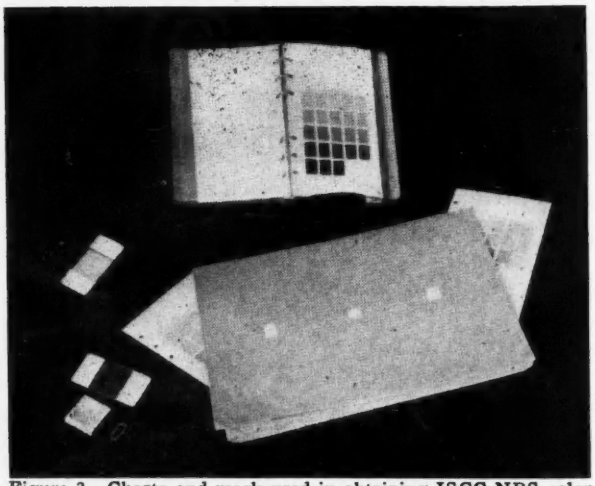


Figure 3. Charts and mask used in obtaining ISCC-NBS color designations.

the mask there should be three rectangular holes the size of the color chips on the charts. Such a mask and charts are shown in Figure 3. Because textiles have a flat surface, they can be placed directly behind the center opening of the mask. One or more layers may be used, as may seem necessary. The angle of illumination and viewing, particularly on glossy silks, must be kept constant, preferably at 45° illumination, normal viewing. If the color should be a red, slightly toward the purple, the two Munsell charts nearest this hue would be selected and placed, one under each side of the mask. The two color charts are then adjusted until an estimation of hue, of lightness, and of chroma of the textile may be made to one step of hue (in 100), to 0.1 step of lightness, and to 0.1 step of chroma. The name is then looked up by reference to the boundary charts published by Judd and Kelly[2].

Because abbreviations will be probably used more often than not for the ISCC-NBS color designation, a notation for recording them is given in Table 1. Capital letters refer to the noun form of the hue name; lower case letters are used for the adjective form. Since blue, brown, and black all begin with B, they are distinguished by writing the abbreviation B for blue, Br for brown, Bl for black. Green and gray are distinguished by using G for green, Gr for gray. Orange and olive are distinguished by using O for orange, Ol for olive.

The color name charts of this system are illustrated in figures 4-10.

It is expected that the first important use of these names will be made in the next revision of the National Formulary. This volume and the U. S. Pharmacopoeia, in which the names will also appear either in the present revision or the one following, are required on the shelves of all pharmacists. Thus there will be widespread acquaintance with these names. Another important application will be in the field of soil science, the ISCC-NBS names applicable to soil colors to be illustrated by charts containing color samples of the names. Various other groups are meanwhile

TABLE 1

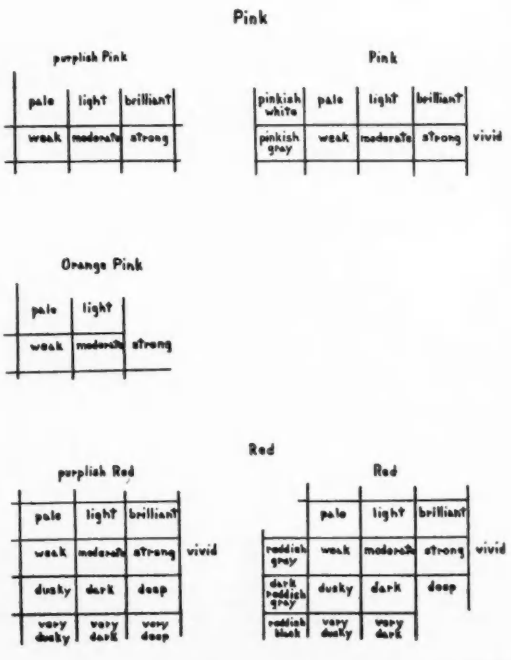
Abbreviations for use with ISCC-NBS system of designing colors

Noun form of hue	*Adjective form of hue*	*Adjective modifiers*
Pk pink	pk pinkish	lt light
R red	r reddish	dk dark
O orange	o orange	wk weak
Br brown	br brownish	str strong
Y yellow	y yellowish	mod moderate
Ol olive	ol olive	med medium
G green	g greenish	viv vivid
B blue	b bluish	
P purple	p purplish	
Wh white		*Adverb modifier*
Gr gray		
Bl black		v very

studying the application of these color designations in fields where a standard system of this sort may be useful.

It is necessary to warn the person who may overenthusiastically suppose that all his color name or color designation problems have now been solved. The ISCC-NBS names are standard, but they are applicable only when it is possible to group a number of distinguishable colors under a single color name. There are 312 names in the system, a number quite sufficient for naming colors from memory, but since it is estimated that man can distinguish more than ten million surface colors, such a system of color names will not answer all problems of color designation. When more than 312 names are

Figure 4. ISCC-NBS color designations for the pink and red series.



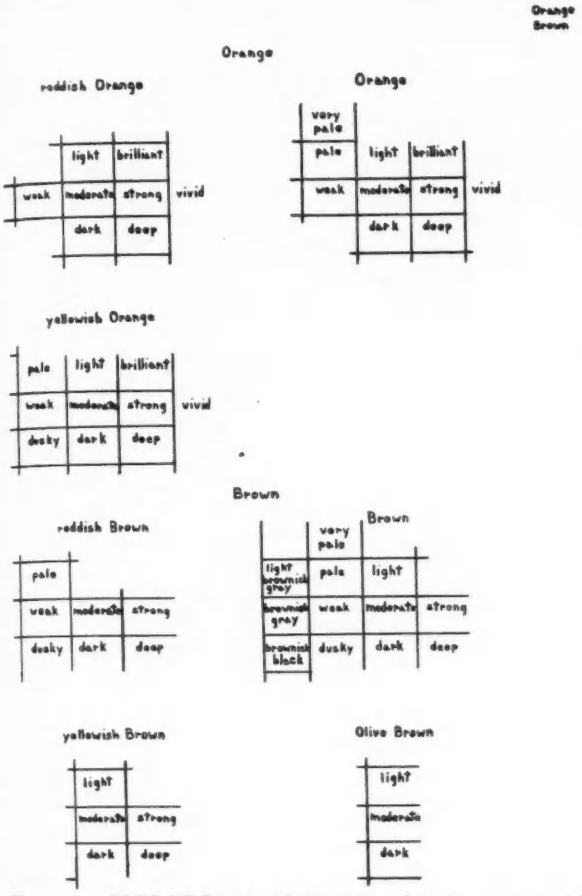


Figure 5. ISCC-NBS color designations for the orange and brown series.

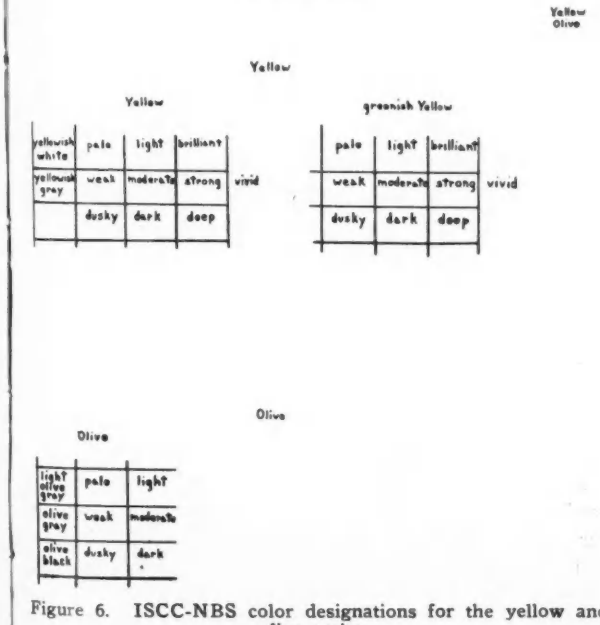


Figure 6. ISCC-NBS color designations for the yellow and olive series.

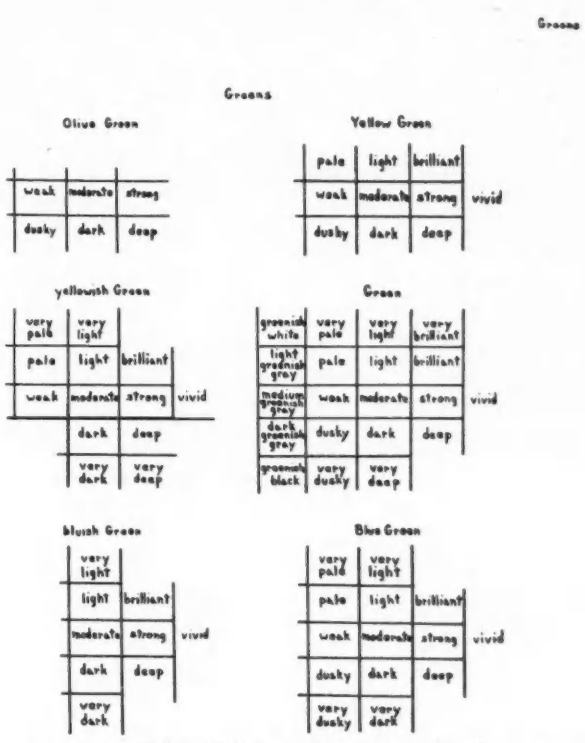


Figure 7. ISCC-NBS color designations for the greens.

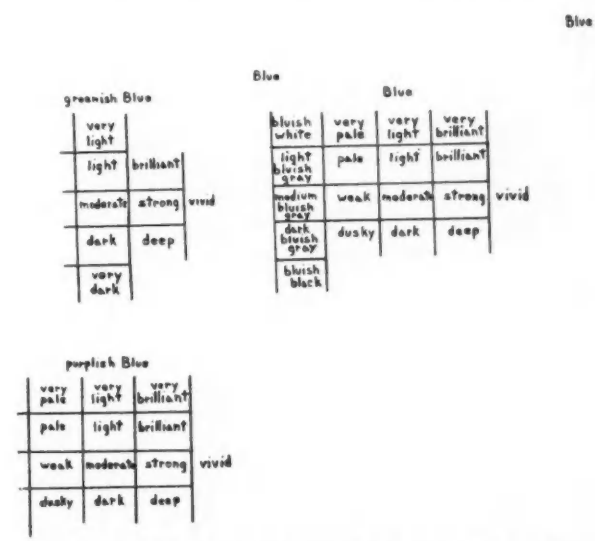


Figure 8. ISCC-NBS color designations for the blues.

necessary, a system of numerical notation is advised, for such notations can readily be extended to any number of colors, while names cannot.

In the textile industry there are problems to which this system is applicable, but it is not meant to replace color names used for sales appeal in merchandising. Nor can it replace standards such as those of the Textile Color

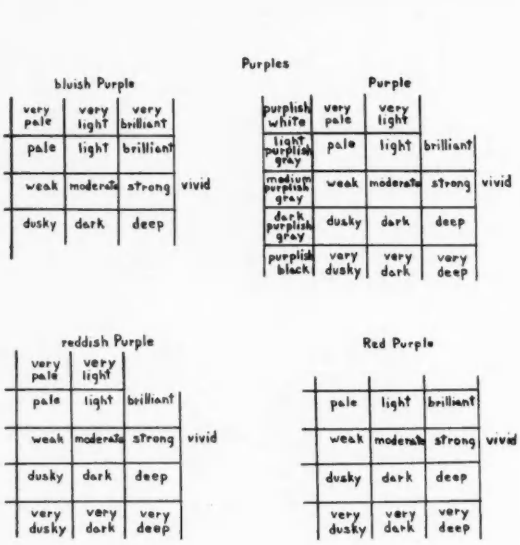


Figure 9. ISCC-NBS color designations for the purples.

Figure 10. ISCC-NBS color designations for the grays.

Card Association of the United States, which have a very strict tolerance and must be matched with close fidelity if problems of matching in costumes are to be avoided after various types of merchandise are made up. It can be used for purposes of grouping similar colors. It can be used also to make fashion and seasonal names more understandable. Do you, for example, know that Capucine, Chamoline, and Alesan are color names? According to the ISCC-NBS system, Capucine is a moderate yellow, Chamoline is a dusky yellowish orange, and Alesan is a pale to light brown. Dozens of other quite color-meaningless names can be visualized with good approximation by the use of these standard names.

And for such problems as those to which it is applicable, it is to the advantage of all groups concerned that they be acquainted with the ISCC-NBS system and use it. It is in order to acquaint you with this standard method and to urge that you use it in all problems where it is applicable, that I call it to your attention today.

The adoption of a report by the Inter-Society Color Council, and the consequent publication of that report by the National Bureau of Standards have provided standard color names in theory; only the widespread use of these color names will make them standard in fact. From now on it is you, and I, and all others to whom color naming problems come, who will actually be responsible for the degree of success this standard system of color designation will have.

The Present Trend of
Textile Finishing*

T. H. ROBERTS**

IN the history of the textile industry, probably there has been no period during which there has been such rapid advancement in the application of new methods and new materials for the improvement and diversification of textile finishing as we have witnessed during the past decade. The enormous activity in this field has undoubtedly been stimulated and to some degree necessitated by the economic situation which has been responsible for extraordinarily keen competition during this period. This competition has brought drastically low prices to the industry, necessitating the constant improvement of methods and equipment to operate successfully under these conditions. To meet this competition, or rather to escape it in so far as possible, many operators in the textile finishing field have instituted extensive research for the purpose of developing new methods and new products, and have succeeded in creating new fabrics and new finishes for older fabrics in enormous varieties.

Another factor in the rapid development of these new products and ideas, has been the remarkable advance in our synthetic organic chemical industry. Born during the first World War and stimulated by farsighted research programs, it has had a truly remarkable growth and now constitutes one of the most important factors in the growth

*Presented at meeting, Piedmont Section, April 27, 1940.
**Arnold, Hoffman & Co., Inc.

and economy not only of the textile industry but of our nation as a whole.

As a result of the development of this great synthetic organic chemical industry, we now have available in unlimited quantities, chemical raw materials and intermediates which but a few years ago were laboratory curiosities and unobtainable at any price. From this abundant and rapidly expanding supply of basic materials the textile industry and chemical manufacturers of finishing materials have already developed a great number of new products and this number is rapidly increasing. These products include new synthetic textile fibers differing in nature and properties from anything heretofore known, new processing chemicals including penetrants, detergents, and bleaching agents incorporating efficiency and stability far beyond those of the best products available but a few years ago, and last, but not least, an endless variety of new finishing materials by means of which the textile finisher can produce effects heretofore unobtainable.

The introduction of this bewildering array of new materials into the textile industry in such a comparatively brief space of time has undoubtedly tended to bring with it a certain amount of confusion. It is apparent that the flood of these new synthetic products coming into the market as a result of intensive research programs has resulted in conditions where there are more products available than we know how to make use of. This indicates that research in the application of these new materials has not kept pace with the speed with which they have been put on the market. A great deal of effort is being made to overcome this difficulty and chemical manufacturers as well as the textile manufacturers have found it necessary to make large increases in their technical forces for this purpose.

In the case of the former, the past few years have witnessed a large increase in technical personnel devoted to the introductions and servicing of new products.

Any attempt to describe or even enumerate all of the newer developments in the textile finishing field with any degree of thoroughness could not be accomplished within the period allotted for this paper. However, the general trend can be illustrated by a brief discussion of two outstanding groups of products which represent two of the most important developments in the application of synthetic organic chemistry to the finishing of textiles.

SYNTHETIC RESINS FOR FINISHING

Under the general heading of synthetic resins, we find included a multitude of products obtained from many different sources of raw materials and differing widely in composition and properties. Generally speaking, however, they are highly polymerized chemical compounds having no definite crystalline structure, which have been built up by synthesis from comparatively simple basic materials. They may vary in consistency from viscous fluids to hard brittle solids. Many products, which are not resins in any true sense of the word, have come to be associated with the latter in our minds because of the great similarity in their general properties and methods of use. Among these might be classed the rapidly increasing group of cellulose derivatives which have recently become of increasing importance.

As stated in the previous paragraph, the various resins vary widely in their properties, both chemical and physical. Each product must be considered from the standpoint of its own individual characteristics in connection with any application to which it may be put. Some resins are thermoplastic, while others are of the thermosetting type. This difference is of great importance in determining the conditions under which they must be applied. Resins also vary widely in respect to color, stability, and consistency. For use in textile finishing it is essential that the resin, after it has been properly applied, should be colorless or nearly so, free from odor, stable to atmospheric conditions, and to the requirements of the service for which it is intended, and that its consistency, after application, be such as to impart the desired feel or handle to the goods. Many resins have been developed, having, to a highly satisfactory degree, some of the desirable properties listed above, but few, if any, possess them all.

When we examine the list of resins which have met these requirements to greater or less degree, we find that for the most part they may be put into four large groups or classes, each of which has certain common characteristics in chemical structure or physical behavior. There are, undoubtedly, a number of commercial products not included in these four groups, but at the present time, these are relatively the more important.

The following is a brief description of these groups in which the outstanding properties and applications have been outlined:

Cellulose Derivatives

As the name implies, this group is derived from cellulose as a raw material by various methods of chemical treatment. The principal products to be considered in this group are:

1. *Cellulose Xanthate*: Better known as viscose. It is derived from cotton linters or wood pulp, by treatment with caustic soda, followed by solution in carbon bisulfide. It forms a clear syrupy solution which may be applied to fabrics in this form and then regenerated to form a pure cellulose coating which, after bleaching, provides a finish similar in hand to that provided by starch, but which is one of the most permanent finishes that can be produced by application methods. However, the elaborate equipment required to operate this process, plus the high degree of technical skill and control necessary for successful production, have limited its use to a few highly specialized operations.

2. *Cellulose Acetate*: An ester of cellulose produced by treating the latter with acetic acid, or more properly, acetic anhydride. Thermoplastic and easily soluble in many organic solvents, it lends itself to many applications where these properties are useful as in the production of

non-flammable lacquer coatings and in the manufacture of fused or so-called starchless collars. For the latter purpose, it is usually used in the form of a coarsely woven cloth which is placed between the layers of fabric forming the collar, and after moistening with a suitable solvent such as acetone, fused into place by heat and pressure.

3. *Ethyl Cellulose*: A cellulose ether which may be produced by reacting cellulose with di-ethyl sulfate under suitable conditions. This is a white, thermoplastic material, having exceptionally good resistance to the action of alkalies and mild acids. At the present time, it is used primarily in the textile finishing trade in the form of various types of emulsions. Dissolved in suitable solvents, it is readily emulsified and in this form is the basis of many printing compositions which have found considerable favor in the textile printing trade. Development of emulsions for the production of plain shades and for permanent types of finish has also received a great deal of attention recently.

4. *Hydroxy Ethyl Cellulose*: A substituted ether or cellulose, produced by various chemical processes, it is a white, fibrous material which has the outstanding characteristic that it is readily soluble in strong solutions of caustic soda. In the form of such solutions, it may be applied to the fabric in the grey and subsequently fixed by treatment with acid, yielding a very stable finish which may be kier boiled and bleached without losing the full firm hand characteristic of this type of finish. However, the high alkali concentration required in its application has served to limit the field of application for this material.

Urea Formaldehyde Resins

These consist chiefly of products derived from reacting urea with formaldehyde under carefully controlled conditions. Many variations are obtained by altering the proportions of these materials and the conditions under which they are combined. Modifications are also possible by using substitutes for urea which produce a similar type of reaction. The ultimate product of this reaction is a white, brittle, insoluble material. However, by careful control, the reaction may be stopped at an intermediate stage and products obtained which are soluble in water. It is in this form that the resin is usually supplied to the finishing trade. After the addition of suitable catalysts to solutions of these intermediate products, they are applied to the fabrics and the reaction carried to completion by subsequent curing operations, involving the application of relatively high temperatures.

One of the most notable uses to which these resins have been put is for the production of anti-crease finishes. In this process a solution of the resin is prepared containing a suitable catalyst. The fabric is then padded in this solution and dried. The goods are then cured at a temperature of 300° to 340° F., thereby polymerizing the resin. The goods are then scoured to remove surface resin. This process exemplifies the use of a thermosetting type of resin.

The urea-formaldehyde resins have also found many applications as a replacement for starch finishes where a greater degree of permanency is desired. However, the somewhat harsh feel obtained with the straight resin is frequently modified by the addition of softer resins or other types which act in the nature of plasticizers. Many times, the softening can be obtained by the use of certain, recently developed, synthetic softening materials of the substantive type. These products show remarkable effectiveness combined with a high degree of permanence.

Urea-formaldehyde resin is also offered to the trade in a wide variety of combinations in which the purpose of the resin is to provide greater permanence with especial reference to an improved wash fastness of the finish. In combination with protein materials, it has appeared on the market as a semi-permanent finish.

In the field of textile printing, we find that urea-formaldehyde resin combinations are useful in the production of certain special effects, such as pigmented and resist effects.

Alkyd Resins

This group is represented by many widely diversified types, a large number of which have been developed for use in the paint industry and are of little or no use for textile finishing. Essentially, they are produced by the condensation of a suitable organic acid, such as phthalic anhydride, with glycerine or related products followed by suitable polymerization. Countless variations are possible by adding oils or their corresponding fatty acids to the condensation process. In this manner are produced the modified alkyd resins.

For textile finishing, the alkyd resins are used either alone or to modify or plasticize resins in other groups, as previously indicated. They are often used for this purpose in the production of emulsions for printing and finishing.

As an adhesive and binding material, the alkyds have shown a great deal of promise. We have recently seen the widespread use of a series of resins of the alkyd type, marketed in the form of aqueous solutions in some cases, while in others, they have been put out in the form of emulsions. In back-filled work and for non-slip finishes on rayon, they are rendering excellent service. However, the use of emulsions in many instances, is fraught with inconveniences owing to the tendency of the emulsion to break down due to the loss of volatile solvents by evaporation during extended runs. New resins, appearing in this field, which incorporate excellent binding and adhesive power in a water soluble form apparently have all the advantages of the emulsion type, and at the same time show much more stability in use.

Methacrylate Resins

This group represents a development in the resin field which has been applied to textiles during the past couple of years. Built up by a series of synthesis from acrylic acid derivatives, the basic substance from which the bulk of these resins is derived is the methylester of methacrylic acid. By successive degrees of polymerization, a series of resins have been built up which exhibit a remarkable degree of elasticity and strength combined with excellent color. They are thermoplastic in nature and are produced

in emulsion form. The finishes obtainable with this group of resins are outstanding in stability and wash fastness, and are generally fairly permanent.

Concluding the discussion of resins with this brief survey, we now take up another very significant development in the present trend in finishing of textiles.

SUBSTANTIVE FINISHING MATERIALS

No discussion of recent developments in textile finishing would be complete without a discussion of this comparatively new group of textile finishing auxiliaries. Classified under this heading, are included the rapidly increasing group of products, listed variously as cation fixing agents, substantive softeners, permanent softeners, permanent water repellents, etc.

The outstanding characteristic of all of these products is their affinity for textile fibers which is, in many instances, analogous to that of dyestuffs. Because of this affinity, we find that these products are absorbed by the textile fibers from relatively dilute solutions and due to their powerful surface action produce a highly efficient, softening effect.

Although these products are, for the most part, highly complex amino derivatives with a much higher unit cost than the time honored softeners that we have been accustomed to use in the past, their actual cost in use is often lower than these cheaper, but less effective materials. Recent additions to the field of substantive softeners include improved products of outstanding softening power coupled with excellent stability to heat, light and storage conditions. With a recently developed type, dyed fabrics can be treated without danger of alteration of shade or impairment of light fastness. In this connection, it should also be pointed out that many dyestuffs are improved in fastness to water and perspiration to a considerable degree by some of these new substantive softeners.

Probably, it is unnecessary to point out that there have recently been some remarkable developments in this field in the production of permanent water-repellent finishes. These are complex, nitrogenous compounds, having considerable affinity for cotton and cellulose fibers. By treating the latter with these compounds followed by curing at relatively high temperatures, a hydrophobic condition is produced on the cloth which, it is claimed, will ensure complete water-repellence for the practical life of the garment.

New developments are constantly taking place in the production of substantive finishing materials. This field is probably the newest and least explored of any in the textile industry, and seems to open up boundless opportunities for research. Ultimately, we may find some of the most important changes in textile finishing methods coming out of these developments.

EFFECT OF NEW DEVELOPMENTS

Now, it may be asked, what effect is this great development in the production of new methods and materials having on the textile finishing industry. A few specific instances will serve to illustrate the trend.

In the textile printing industry, we see the stimulation of an art that has plodded along prosaically with little or no change in methods or equipment for almost three-quarters of a century. New materials have opened up new possibilities of production which in turn have stimulated radical improvements in printing machinery which up to this period has changed very little since machine printing first came into being. New printing vehicles in the form of resin emulsions of various types are taking an important place in the field of textile printing. Water soluble synthetic resins are also being promoted as substitutes for starch thickeners and natural gums. The question naturally arises as to how far the latter will be replaced by the newer materials. Time only can answer this question. Physical limitations inherent in the resin emulsion type of vehicle have provided serious obstacles to its displacement of starch gums for the greater volume of textile printing, and the higher cost and generally poorer color yield of water soluble types of synthetic thickeners have prevented them from competing with starch and natural gums. Within their limitations and for the production of special effects, however, these new products are assuming ever increasing importance.

We have already discussed some of thes uses of resins and synthetic products in the finishing operations. These uses serve to indicate the trend in this direction. With the advent of new materials we see the possibility of new effects that were hitherto unobtainable. Fabrics may be given a wide variety of finishes that retain their character and appearance for the life of the garment. Ordinary types of fabrics can be given properties equalling in many cases the beauty or utility of more expensive materials. Greater stability towards light, heat, and moisture with consequent elimination of discoloration and odor, is available to the finisher by proper selection of new synthetic finishes. To sum up, there is an ever-broadening field where novelty, stability, or permanence are the finisher's prime objective. It is in this field that we see the gradual elimination of the older methods and products in favor of the new.

We should not lose sight of the fact that in spite of all the publicity and enthusiastic salesmanship with which the industry is bombarded in the effort to introduce new products, there are no cure-alls or panaceas for all the ills of the finishing field in sight at present. There is much confusion and uncertainty concerning the possibilities and applications of newly developed products. It is to the best interest of both the producer and consumer of these products that they proceed carefully and conservatively and that they work in fullest cooperation on the problems involved. In this way many of the disappointments due to over enthusiastic promotion of new ideas and products will be eliminated and steady progress made towards the goal of greater efficiency and higher quality to which the efforts of so many workers in our great textile industry are dedicated.

Technical Evaluation of

Textile Finishing Treatments

III—Use of Rank Correlation for Comparison of Data*

LELIA J. WINN** and EDWARD R. SCHWARZ, F.T.I.***

ABSTRACT

The nature and use of the Kendall coefficients of rank correlation and of concordance are presented with details of the methods of computation involved. They are found to be superior to the Spearman coefficient previously used both as a matter of convenience and of statistics. This discussion is given in anticipation of the papers immediately following in this series which will make frequent use of the Kendall rating system.

THE Kendall[1] coefficient of correlation has been adopted as a more efficient measure of rank correlation than that of Spearman[2]. In a distribution where all the possible rankings occur equally frequently the standard deviation of the Kendall coefficient of correlation is less than the standard deviation of the Spearman coefficient. The Kendall coefficient is designated by "Y" and the Spearman coefficient by "ρ." The latter is not distributed normally for a small number (n) of values composing the rank. Since much of the usual work of rank correlation for textiles involves less than 20 values per rank and frequently less than 10 values, use of Y is advantageous since for $n = 6$ or more its distribution approximates the normal. Hence the determination of the significance of the coefficient may be made by usual statistical methods such as the "t" test which will be discussed in this connection. It is further true that there is a high degree of correlation between ρ and Y so that while the data of the present experimental work have been re-computed in terms of Y, there has been no change in the general conclusions. They may now be studied much more critically, however, which is important.

When no objective ranking is used as a standard, Y measures the correlation between two rankings by comparing one ranking to the other after it has been placed in objective order. Either ranking may be chosen as objective since the value of Y is the same in both cases. When two stiffness rankings are determined by two different methods and compared, it is not possible to choose one as the standard order, so that this type of correlation is suitable. Y is psychologically correct in its application since it makes a comparison of each number of the rank with the others in that rank, a procedure which is followed in actual handling of the material. It allows a plus mark for each comparison made correctly and subtracts a mark for each error.

Y is derived by the comparison of a ranking (a) with one in the objective order (b) (1, 2, 3 . . . etc.). Each succeeding number in rank (a) is compared in turn with the succeeding numbers of that rank (a). Each pair of numbers is considered in turn and those in the correct sequence are given a value of +1, while those in the inverted sequence are given a value of —1. The sum of these values is denoted as Σ for the rank.

Thus to compare the ranking of the stiffness values for Bending Length, *c*, against the values for the Flexural Rigidity, *G*,

Rank G = 1 3 2 4 6 5 7 9 8 10 (where each number refers to a particular set of specimens)
Rank c = 1 5 2 3 4 8 9 7 6 10

the order of *G* may be transposed to the objective order and the corresponding values of *c* are written below.

Rank G (arranged objectively) = 1 2 3 4 5 6 7 8 9 10 n = 10
Rank c (to correspond) = 1 2 5 3 8 4 9 6 7 10

Number 1 of Rank *c* makes nine pairs of numbers in the correct sequence when it is compared with each succeeding number in turn so that its value is +9. Number 2 makes 8 pairs of numbers in the correct sequence; number 5 makes 5 pairs of numbers in the correct sequence and two in an inverted sequence so that its value is +3; etc., giving:

Number	*Pairs in the Correct Sequence*	*Pairs in the Inverted Sequence*	*Value*
1	9	0	+9
2	8	0	+8
5	5	2	+3
3	6	0	+6
8	2	3	—1
4	4	0	+4
9	1	2	—1
6	2	0	+2
7	1	0	+1
10	0	0	0
			$\Sigma = +31$

*Part I of this series was published in the Am. Dyestuff Reptr. 28, p. 138; Part II Am. Dyestuff Reptr. 28, p. 688.
**A.A.T.C.C. Research Assistant at M.I.T.
***Professor of Textile Technology, M.I.T.
[1]*Biometrika*, XXX, June, 1938.
[2]*Textile Research*, Vol. X, No. 1, Nov., 1939, p. 14-16, and Am. Dyestuff Reporter, 28, p. 688.

The maximum score, which could be made when the rankings are both in the objective order, would be 45 when n = 10.

$$\Upsilon = \frac{\text{actual score}}{\text{maximum possible score}} = \frac{31}{45} = 0.69$$

Generally the maximum score is $(n-1) + (n-2) \ldots +1 = \frac{n(n-1)}{2}$.

Thus $$\Upsilon = \frac{2\Sigma}{n(n-1)} = \frac{62}{90} = 0.69.$$

A shorter method is used in actual practice. Suppose Rank "G" is transposed to the objective order and Rank "c" is transposed to correspond. As seen above it will be

Rank c = 1 2 5 3 8 4 9 6 7 1 0 n = 10

Considering Rank "c" we note that there are 9 figures to the right of "1" which are greater than "1."

Similarly there are 8 figures to the right of "2" which are greater than "2"; 5 figures to the right of "5" which are greater than 5, etc., giving

(To the right of)	*(Number of greater figures)*
1	9
2	8
5	5
3	6
8	2
4	4
9	1
6	2
7	1
10	0
	Sum = 38 = K

If the rankings were the same, so that both were in the objective order after "G" was transposed, the sum would be 45. Thus to find the number of figures lying to the right of successive numbers in the rank which are *less* than these numbers in magnitude we subtract K from 45. Giving 45 — K = 7 which is the sum of number of lesser figures.

Since we have taken Σ to equal the difference between the number of figures which are greater and the number of figures which are less than the noted values, then

$$\Sigma = 38 - 7 = 31$$

which agrees with the result obtained by scoring (+1) and (—1) as already shown.

$$\text{In general } \Sigma = 2K - \left[\frac{n(n-1)}{2}\right]$$

$$\text{or } 2(38) - \left[\frac{10(10-1)}{2}\right]$$

$$\text{and } \Sigma = 76 - 45 = 31$$

There are several other methods of computing Σ which are of value in other circumstances. For these the reader is referred to *Biometrika* XXX (June, 1938).

It has already been stated that it makes no difference which rank is arranged objectively. For instance, if Rank c were so arranged rather than Rank G, we would have

Rank c (arranged objectively) = 1 2 3 4 5 6 7 8 9 10 n = 10
Rank G (to correspond) = 1 2 4 6 3 8 9 5 7 10

and

(To the right of)	*(Number of greater figures)*
1	9
2	8
4	6
6	4
3	5
8	2
9	1
5	2
7	1
10	0
	Sum = 38 = K

and as before $\Sigma = (2)(38) - 45 = 31$

It is possible to check a computation by counting the greater numbers to the left and then $\Sigma = \frac{n(n-1)}{2} - 2L$.

The Kendall rating as compared to the Spearman rating given in a previous paper[2] follows:

Kendall Rating

Formula: $\Upsilon = \frac{2S}{n(n-1)}$ $\quad S = 2\Sigma K - \frac{n(n-1)}{2}$

Case 1 ($\Upsilon = +1$)

A	B	K
1	1	4
2	2	3
3	3	2
4	4	1
5	5	0
		K = 10

$S = 20 - 10 = 10$, $\Upsilon = \frac{20}{20} = +1$

Case 2* (*Kendall*) $\Upsilon = 0$)

A	B	K
1	5	0
2	1	3
3	2	2
4	4	0
5	3	0
		K = 5

$S = 10 - 10 = 0$, $\Upsilon = \frac{0}{20} = 0$

Case 2* (*Spearman*) $\rho = 0$)

A	B	K
7	5	0
2	1	3
3	2	2
4	3	1
5	4	0
		K = 6

$S = 12 - 10 = 2$, $\Upsilon = \frac{4}{20} = .20$

Case 3 (—1)

A	B	K
1	5	0
2	4	0
3	3	0
4	2	0
5	1	0
		K = 0

$S = 0 - 10 = -10$, $\Upsilon = \frac{-10}{20} = -1$

The t-test where $t = \sqrt{\frac{\Upsilon(n-2)}{1-\Upsilon^2}}$ may be used as a test for significance for both Spearman's ρ and Kendall's Υ. However ρ must be corrected to $\times = \frac{\Sigma d^2}{1/6\,(n^3-n)+1} - 1$ for continuity when n is small. There are n — 2 degrees of freedom. If the value of t is greater than that shown at the .025 level of significance, the two rankings are significantly alike.

Thus when n = 10, there are 8 degrees of freedom and 2.31 is indicated at the .025 level.

*Case 2 in Spearman = 0. But since Spearman distribution is not normal when n is so small, it is seen that where a Spearman ranking $\rho = 0$, the Kendall gives $\Upsilon = .20$. A more random distribution gives $\Upsilon = 0$ while Spearman would be $\rho = .10$.

Spearman

$\Sigma d^2 = 62 \quad \rho = 62.5\% \quad t = -2.27$ is not significant

$\Sigma d^2 = 60 \quad \rho = 63.8\% \quad t = -2.35$ is significant

Kendall

$\Sigma K = 33 \quad Y = 47\% \quad t = 2.20$ is not significant

$\Sigma K = 34 \quad Y = 51\% \quad t = 2.35$ is significant

but values near the level are too close and indicate a need for more specimens.

Sample Designation (*)

A_cTK	Treated Thick Cotton
PTK	Plain Thick Cotton
TC_1	Tracing Cloth
ULO	Unlaundered Organdie
LO	Laundered Organdie
A_cC	Treated Congo Cloth
PC	Plain Congo Cloth
A_cTh	Treated Thin Cotton
PTh	Plain Thin Cotton
V	"Velvet," a pile fabric

A comparison of the Spearman ρ and Kendall Y values in the tests already published confirms that the pairs shown to be probably significantly alike by Spearman rating actually are alike.

Rankings

	Bending Length	*Rigidity*	*Bending Modulus*	*Schiefer Flexometer*	*Chord Length (Drape Tester)*	*Radius of Curvature (Drape Tester)*	*Gurley Flexometer*
A_cTK	1	1	3	1	1	1	1
PTK	5	3	8	3	2	2	2
TC_1	2	2	1	2	10	10	4
ULO	3	4	2	5	3	4	9
LO	4	6	4	7	4	3	10
A_cC	8	5	7	6	6	6	3
PC	9	7	9	8	7	5	5
A_cTh	7	9	6	9	8	7	7
PTh	6	8	5	4	9	9	8
V	10	10	3	10	5	8	6

Spearman ρ

	Bending Length	*Rigidity*	*Chord Length (Drape Tester)*	*Radius of Curvature (Drape Tester)*	*Schiefer Flexometer*	*Gurley Flexometer*
Gurley Flexometer	.12	.55	.25	.25	.43	—
Schiefer Flexometer	.82	.88	.21	.25	—	
Radius of Curvature (Drape Tester)	.35	.47	.90	—		
Chord Length (Drape Tester)	.30	.42	—			
Rigidity	.82	—				
Bending Length	—					

Kendall Y

	Bending Length	*Rigidity*	*Chord Length (Drape Tester)*	*Radius of Curvature (Drape Tester)*	*Schiefer Flexometer*	*Gurley Flexometer*
Gurley Flexometer	.07	.38	.20	.16	.38	—
Schiefer Flexometer	.69	.82	.20	.25	—	
Radius of Curvature (Drape Tester)	.20	.42	.87	—		
Chord Length (Drape Tester)	.16	.38	—			
Rigidity	.69	—				
Bending Length	—					

The rankings are from stiffness values which are the grand averages of the readings obtained in testing the front and back of each fabric in each direction. In the previous paper only the averages of the front readings were available and in some cases the ranking only has been changed.

The foregoing treatment has dealt with the comparison of two ranks only. Kendall (*Annals of Mathematical Statistics,* X, No. 3, September, 1939) has suggested also a coefficient of concordance, W, to use when there are more than two (or "m") rankings to be compared. W is derived from a consideration of the sums of the columns in the "m" rankings. If the rankings were similar the sums would be m x 1, m x 2, m x 3, etc. If the rankings had no relationship the numbers in the columns would occur at random and the sums obtained with *m* rankings would tend to be equal. W is a comparison of the sums obtained with "m" rankings to the maximum possible values of the sums which are present when the rankings are all in exactly the same order. W varies from +1 to 0.

Taking the stiffness rankings obtained by the different testing methods we have $m = 6$, $n = 10$.

(—*See table at top of next page*—)

The sum of each column (u) shows the amount of correlation between the rankings. Perfect correlation would give 6, 12, 18 . . . 60, although not necessarily in that order. With less correlation the values of u would all be about 33. The Σu is fixed for $m = 6$, $n = 10$ but the sum of u^2 varies with the values of u.

The variance of these sums is the sum of the squares of the deviations of the values of u from their mean which is

$$\text{Mean} = \frac{m(n+1)}{2}$$

Thus, if we let S denote the variance of the sums we have

$$S = \Sigma u^2 - \frac{(\Sigma u)^2}{n}$$

or for the example noted,

$$S = 12548 - \frac{(330)^2}{10}$$

$$S = 1658.$$

**Textile Research*, Vol. X, No. 1, Nov., 1939, p. 14, Table 2.

Bending Length	1	5	2	3	4	7	6	8	9	10	
Rigidity	1	3	2	4	6	9	8	5	7	10	
Chord Length (Drape Test)	1	2	10	3	4	8	9	6	7	5	
Radius of Curvature (Drape Test)	1	2	10	4	3	7	9	6	5	8	
Schiefer Flexometer	1	3	2	5	7	9	4	6	8	10	
Gurley Flexometer	1	2	4	9	10	7	8	3	5	6	
Sums = u =	6	17	30	28	34	47	44	34	41	49	$\Sigma u = 330$
Squares of sums = u^2 =	36	289	900	784	1156	2209	1936	1156	1681	2401	$\Sigma u^2 = 12{,}548$

Now the largest value possible for S is obtained when the rankings are all alike, as

$$S_{max} = \frac{m^2(n^3 - n)}{12}$$

and

$$W = \frac{S}{S_{max}} = \frac{12S}{m^2(n^3 - n)}$$

or for the example noted

$$W = \frac{12(1658)}{35640} = 0.56$$

To determine the significance of the coefficient of concordance (W) we may use the usual Z test of statistics for the significance of a variance where

$$Z = 1/2 \ln \frac{(m-1)W}{1-W}$$

also

$$n_1 = (n-1) - \frac{2}{m}$$

and

$$n_2 = n_1 (m-1)$$

Thus for the example noted

$$Z = 1/2 \ln 6.4 = 0.93$$

$$n_1 = (10 - 1) - \frac{2}{6} = 8\frac{2}{3}$$

$$n_2 = (8\frac{2}{3})(6 - 1) = 43\frac{1}{3}$$

$$f_1 = n_1 - 1 = 7\frac{2}{3}$$

$$f_2 = n_2 - 1 = 42\frac{1}{3}$$

$$Z_c < 0.6$$

Since $Z = 0.93$ is greater than $Z_c < 0.6$ the rankings are significantly the same.

When m and n are small, it is necessary to correct "W" for continuity and W′ is used in its place, thus

$$W' = \frac{S-1}{\frac{m^2(n^3-n)}{12} + 2}$$

or

$$W' = \frac{1657}{\frac{35640}{12} + 2} = 0.56$$

To illustrate the use of the Kendall coefficient of concordance (W) consider the following simple cases of three ranks of five items each.

For Case 1:

A	1	2	3	4	5
B	1	2	3	4	5
C	1	2	3	4	5
u =	3	6	9	12	15

$\Sigma u = 45$ and $(\Sigma u)^2 = 2025$

u^2 =	9	36	81	144	225

$\Sigma u^2 = 495$

or

A	1	4	3	2	5
B	1	4	3	2	5
C	1	4	3	2	5
u =	3	12	9	6	15

$\Sigma u = 45$

u^2 =	9	144	81	36	2..

$\Sigma u^2 = 495$

and

$$S = 495 - \frac{2025}{5}$$

$$S = 90$$

$$W = \frac{1080}{1080} = +1$$

This indicates perfect agreement.

For Case 2

A	1	2	3	4	5
B	3	4	5	1	2
C	5	3	1	4	2
u =	9	9	9	9	9

$\Sigma u = 45$ and $(\Sigma u)^2 = 2025$

u^2 =	81	81	81	81	81

$\Sigma u^2 = 405$

and

$$S = 405 - \frac{2025}{5}$$

$$S = 0$$

$$W = \frac{0}{1080} = 0$$

which indicates no similarity in the rankings.

The value of rank correlation for the analysis of data of the sort obtained by any one type of test on two or more

series of specimens which are to be classed in definite order of excellence is evident. The technique is not widely familiar and the application of the method has only infrequently been applied to problems arising as a result of textile research. Not only, therefore, is the foregoing of interest and importance for the present work, but also for other investigations where data must be similarly presented.

ONE HUNDRED AND TWENTY-EIGHTH COUNCIL MEETING

THE Council holds its 128th meeting at the Engineers Club in Boston, on Friday morning, June 21, 1940. Present were President Carl Z. Draves, presiding; William R. Moorhouse, Treasurer; Louis A. Olney, Chairman of the Research Committee; William H. Cady and P. J. Wood, Past Presidents; Kenneth H. Barnard and John N. Dalton representing Northern New England; Frederic A. Prisley, representing Rhode Island; George L. Baxter, J. Robert Bonnar and Harold W. Stiegler representing New York; Charles A. Seibert, William A. Stringfellow and Herbert S. Travis representing Philadelphia; Bertil A. Ryberg, Associate Director of Research; and Harold C. Chapin, Secretary. The Secretary's report of the 127th Council meeting and balance sheet of June 18, and the Treasurer's report of June 21, were accepted. A report from the Treasurer of the Philadelphia Section was approved.

It was voted that the next audit of the Treasurer's and Secretary's accounts be in August, 1941. The Secretary, John N. Dalton and Roland E. Derby were appointed a committee to offer the facilities and advice of the Association to the Federal Government and its agencies in the defense program. It was voted that provision be made for a retirement annuity for Mr. Ryberg. An appropriation was made for continuation of the Research on Textile Finishes at the Massachusetts Institute of Technology through the current calendar year. Contents were approved for the proposed pamphlet outlining the aims and accomplishments of the Association. An outline of the program for the General Meeting in New York, October 18 and 19, was presented and approved. Mr. Ryberg reported.

Each of the following was elected to the class of membership specified, as of thirty days from publication of application, provided no objection be received meanwhile by the Secretary:

Senior

G. H. Blasius	J. M. Jackson	C. F. Nelson, Jr.
H. H. Broadfoot	Q. C. Jordan	R. H. Nuttall
G. Brownlee, Jr.	G. Kampf	H. J. Rupright
L. E. Carroll	C. G. Krebs	T. L. Scala
E. N. Chapman	V. J. Krukonis	M. Schwartzman
C. A. Cohen	A. H. Leonard	R. J. Singer
S. N. Cummings	H. N. Logan	G. A. Spear, Jr.
S. N. Galliano	E. M. May	W. R. Steele
W. L. Goddard	P. M. McLarty	H. A. Sweet
K. R. Gray	D. R. Neil	F. W. Warrington
F. R. Hutt		E. B. Worrell

Junior

J. E. Barnhill, Jr.	C. B. Estes, Jr.	J. A. Stapleton
R. D. Blum, Jr.	J. A. Feifer	J. P. Thornton
W. F. Brommelsick	N. H. Nuttall	W. B. Worsman
	L. A. Stanley	

Associate

N. M. Agnew	W. D. Evans	W. J. Kirby
J. H. Almand	F. C. N. Jerauld	E. K. Moore
H. Black	G. A. Jonic	E. R. Ravenel
L. L. Brooks	W. J. Kastner	W. E. Scheer

Student

R. G. Boulé	R. W. McCartney	S. Szopa
L. R. Corcoran	A. J. Moreau	S. W. Taylor
G. J. Mandikos	L. A. Schiffer	F. A. Walker

Each of the following was transferred from other classifications to Senior—A. F. Blackburn, H. L. DeTurck, G.

SECRETARY'S BALANCE SHEET—JUNE 18, 1940

	Applications	*Dues, Regular and Reinstate.*	*Dues, Corporate and Sustaining*	*Miscellaneous*	*Bank Charges*	*Totals*
Brought forward and received by Secretary, Nov. 1, 1939, to April 13, 1940	$1,055.00	$7,988.54	$2,340.00	$701.46	—$4.52	$12,080.48
Received by Secretary, April 13 to June 18, 1940	307.50	252.00	375.00	295.20*	— .75	1,228.95
Total received	1,362.50	8,240.54	2,715.00	996.66	— 5.27	13,309.43
Transmitted to Treasurer	1,265.00	8,205.54	2,340.00	794.06		12,604.60
Leaving to order of Secretary	97.50	35.00	375.00	202.60	— 5.27	704.83

Miscellaneous Items*

Year Books	$93.50	Crockmeter cloth	2.50
Reporters	71.60	Carbonizing reports	6.00
Button	1.50	Launderometer royalties	95.00
Knitted tubing	9.00		
Dyed Standards	16.10		$295.20

Dobson, H. H. Latham, A. V. Morrell, H. F. Munroe, T. F. O'Brien, F. S. Perkerson.

Respectfully submitted,

HAROLD C. CHAPIN, *Secretary.*

ONE HUNDRED AND TWENTY-FIRST MEETING OF THE RESEARCH COMMITTEE

THE 121st meeting of the Research Committee followed the Council meeting in Boston on Friday afternoon, June 21, 1940. Present were Chairman Louis A. Olney presiding, G. L. Baxter, K. H. Barnard, J. R. Bonnar, W. H. Cady, H. Christison, R. E. Derby, C. Z. Draves, W. C. Durfee, E. Freedman, W. R. Moorhouse, G. A. Moran, F. A. Prisley, B. A. Ryberg, E. R. Schwarz, C. A. Seibert, H. W. Stiegler, W. A. Stringfellow, H. S. Travis, B. Verity, P. J. Wood, and H. C. Chapin, Secretary.

Professor Schwarz showed and discussed diagrams plotted with the Drapemeter from a variety of fabrics. He suggested change in name to Drapetester or Drapeometer, but no action was taken. The Council, reconvening, voted an appropriation to continue the work to the end of the calendar year.

Mr. Seibert reported progress on tests for gas fading of dyed acetate rayon. Mr. Freedman discussed a questionnaire on the subject conducted on behalf of the National Retail Dry Goods Association. The temperature of 170° F. in gas oven for 16 hours, indicated in this questionnaire, was criticized by Mr. Seibert as too drastic, and likely to hinder the adoption eventually of a reasonable test; but it was defended by Mr. Freedman as eliminating threshold cases. Size, shape, insulation, baffling and air circulation of oven; temperature; type of burner; flame shielding; and distance of burner from oven intake, were agreed upon as important factors in testing apparatus. Mr. Freedman was made a member of the Committee on Gas Fading.

Dr. Stiegler discussed plans of the Committee on Waterproofness of Fabrics, recently reorganized under his Chairmanship. Mr. Bonnar reported for the Committee on Transference of Color; and Mr. Durfee on Crocking, for which Mr. Freedman suggested substitution of the term Smudging. The construction of some more convenient form of gray crocking standards, similar to those published in the Year Book, was again discussed. Mr. Christison discussed the report on perspiration tests prepared for the coming Year Book.

Mr. Moran demonstrated with samples that rubber balls now furnished with the Launderometer dye wool brown in tests at 180° F., presumably because of lead in the balls, and release of sulfur from the wool at this high temperature. There was no action at 120° F. Mr. Freedman described attachments for the Fade-Ometer, which he had devised and found convenient, and which he offered to patent in the name of the Association.

Upon recommendation of Mr. Cady, his Committee on Textile Printing Pastes was thanked and discharged, though Mr. Cady was retained as the nucleus of a future committee should it be required. Likewise the Committee on Carbonization of Wool was reduced to the Chairman, Mr. Derby. The Committee on Research Program was considered replaced by the new Committee on Standardization and Interpretation.

Respectfully submitted,

HAROLD C. CHAPIN, *Secretary.*

Unemployment Register

Members of the association who are without employment may obtain from the Secretary, or the American Dyestuff Reporter, application blanks for the Unemployment Register. Personal histories and employment records of applicants may be examined by prospective employers.

Twentieth

ANNUAL MEETING AND CONVENTION

OCTOBER 18TH AND 19TH, 1940

HOTEL COMMODORE

NEW YORK CITY

OCTOBER 20TH, AT N.Y. WORLD'S FAIR

General Chairman

PATRICK J. KENNEDY

TECHNICAL PROGRAM

DR. WALTER M. SCOTT, chairman of the Technical Program Committee, is introducing a number of novel features. Among them are two symposiums as follows:—

"Evaluation of the Properties of Finished Textiles"

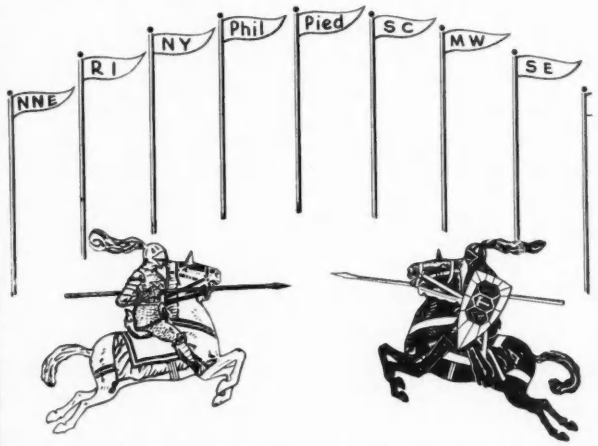
and

"Chemical Aids for the Textile Industry."

Experts will be on hand to lead the discussions and to answer questions from the floor. These timely subjects should prove of the greatest interest.

Auspices of

NEW YORK SECTION



Intersectional Contest

The New York Section announces its contest subject as follows:

New York Section—"Informative Textile Labeling."

Subjects of other sections as previously announced are as follows:

Northern New England—"What is New in New England."

Rhode Island—"The Effect of Modern Finishing Agents on the Light Fastness of Cotton Colors."

Philadelphia — "Variables Encountered in Fadeometer Testing."

Piedmont—"Screen Printing in the South."

Southeastern — "Some Observations on the Tendering of Vat and Naphthol Dyed Army Duck on Total Exposure to Weathering."

OBITUARY

ANDREW W. MUNGALL

ANDREW W. MUNGALL, overseer of dyeing of the Pepperell Manufacturing Co. at Lindale, Ga., for twenty-one years, died at his home in Lindale on July 1st. He was 54 years old.

Mr. Mungall went south from Manchester, N. H., at the age of 16, to enter the employ of his father, the later T. G. Mungall at Pell City, Alabama. During his span of life he had been in charge of several dyeing plants throughout the south. Due to ill health he had been retired the past two years.

He is survived by his wife, a daughter and a son.

• NEW RESEARCH MEMBERSHIP

Realizing that technical developments in the primary textile markets have an all-important bearing on the final serviceability of washable merchandise, the American Institute of Laundering has created a new research membership for primary textile producers, such as finishers and chemical and yarn manufacturers.

This new research service is designed to make the Institute's knowledge and facilities available to these primary producers on a membership basis, so that new fibers, new mixtures, new processes, and new finishes can be properly evaluated for launderability before they arrive at the trial-and-error stage of completed garments in the hands of the consumer.

Previous to this development, the Institute, under its Laundry-Tested and Approved Seal, was only approving or rejecting fully completed merchandise. Its new research service is entirely separate from the Seal program, and is designed as a purely technical research service. At present, the most useful research will be conducted on new finishes and on the development of washable spun rayon blends.

• CALCO RELEASE

An exceptionally brilliant, red-brown, sulfur dye is featured in the sixth of a new series of color announcements being issued by the Calco Chemical Division, American Cyanamid Company.

Calcogene Violet Brown CF, the name of this dye, is recommended by the company for self-dyeing and also for self-shade effects and also in formulations when dyeing cordovan, mahogany and the redder shades of dark brown and tans. According to this announcement brochure Calcogene Violet Brown CF has very satisfactory solubility. This feature combined with its level dyeing properties is said to make it useful for cotton, rayon and linen material in various types of machine.

Another valuable quality of Calcogene Violet Brown CF, as mentioned in this folder, is its exceptionally good affinity for viscose rayon staple fiber, producing shade effects of fastness sufficient to allow its use for blending with dyed wool stock. As its name indicates this dye has a minimum of copper and manganese, making it a "copper free" color.

This new type of announcement that Calco has designed has some unusual features. It forms a part of the effort Calco is making to distribute material more usable and valuable to dyers. This particular series of color announcements, for example, is in flat two-page folders containing a description of the dye and its uses, and swatches of sample material. The folder is standard file size with the name of the color printed on a projecting reference tab.

• TEXTILE TREND

The world textile trend is now definitely toward man-made fibers, it was stated recently by William C. Appleton, president of American Viscose Corporation, Wilmington, Delaware. Mr. Appleton added that this development was bound to be further accentuated in the future. Analyzing the first half of 1940 in the rayon industry, he said that period had witnessed a great deal of work done on developing new fabrics and outlets for yarn and staple. He observed that the industry now appeared to be on the threshold of generally increased use of rayon in various fields, including flat knitting, automobile materials, and certain industrial applications.

The pronounced preference for rayon and the other new textiles, Mr. Appleton noted, was indicated even in countries where there are ample supplies of natural fibers. He pointed out that the present inventory position of the rayon industry in this country was particularly good, though there had been a natural hesitancy due to the European crisis.

Despite the international situation, rayon operations and deliveries continue at capacity for several reasons aside from new outlets. Among these is the greater demand for fine denier yarns requiring proportionately more spindles and the expected effect of an armament program and consequent possible shortage for normal uses of some of the natural fibers.

• HAYNES STELLITE ADDITION

Haynes Stellite Company, Unit of Union Carbide and Carbon Corporation, is expanding its manufacturing facilities at its plant in Kokomo, Indiana, by the addition of a new 75 x 132-ft. factory building, a one-story structure of steel and brick with concrete floor and wide monitor top. Construction was started May 27 and it is expected that the building will be ready for use in August. Some of the features of the building are: continuous steel sash for efficient lighting; large ventilating fans for rapid air change; gypsum roof; modern toilet, locker, and shower facilities.

The new building will house machinery to be used in the manufacture of Haynes Stellite alloy products: metal-cutting tools, hard-facing rods, and special castings for resisting abrasion, corrosion, and heat. This new space will provide room for additional machinery and equipment for the fabrication and finish grinding of Haynes Stellite alloy parts, and at the same time improve the facilities for fabricating and finishing the Hastelloy alloy parts made by the company for resisting severely corrosive conditions in the chemical, process, and other industries.

• NEW COWLES OFFICES

The need for more space, caused by expansion, makes it necessary for the Cowles Detergent Company, Cleveland, Ohio, to move to larger offices. On and after August 31, 1940, the executive and general offices of this company will be located at 7016 Euclid Avenue, Cleveland. There will be no interruption in business affairs during the change in location. All friends and customers of the company are cordially invited to inspect the new quarters after September first.

• FULLER RESIGNS

Frank F. Fuller, since 1937 Vice-President and Director of Borne Scrymser Company, manufacturers of technical oils, has announced his resignation effective July 15th.

For fifteen years Mr. Fuller was associated with the engineering department of Bethlehem Steel Company, joining the sales staff of Borne Scrymser Company in 1929. Becoming sales manager in 1935, Mr. Fuller was two years later elected to the executive position which he leaves. No announcement has been made regarding his future plans.

• OIL SOLUBLE FUGITIVE TINTS

The United States Testing Company, Inc., after several years of study on the tinting of staple fibers, has developed a line of oil soluble fugitive tints for identifying cotton, viscose and acetate staple fibers.

These Cumol Tints are oil soluble dye concentrates to be added to the oil used in conditioning cut staple fibers. Cumol Tints are applied directly to the stock without

the use of any water, said to eliminate delays now encountered in drying out the stock.

The following eight colors are available: red, blue, yellow, green, purple, orange, grass green and brown.

Cumol Tints are available in 5-gallon cans and 50-gallon drums.

The United States Testing Company is distributing, to the trade, sample skeins showing the various shades.

• QUARTERLY PRICE LIST

The Quarterly Price List of the R & H Chemicals Dept., E. I. duPont deNemours & Co., Inc., Wilmington, Del., for July, 1940, has recently been distributed. Copies are available upon request.

• VISCOSE CHANGES

American Viscose Corporation announces that, effective August 1, Edward H. Look, will assume Graeme G. Whytlaw's duties in the Providence, Rhode Island, office of the company. Mr. Whytlaw is going to Marcus Hook, Pa., plant where he will be in the Sales Development Department.

F. Douglas Cudlipp will take Mr. Look's place in the Economics and Statistics Department in the New York office.

Cyril Sumner, Jr., has joined the sales force at the Providence office.

• "MAGIC CARPET"

Greater safety for patrons of modern motion picture theaters is provided by a new "magic carpet" which glows in the dark, according to H. E. Millson of the Calco Chemical Division of the American Cyanamid Co., Bound Brook, N. J.

The new carpet is dyed with special dyes which appear quite ordinary in daylight but glow softly with various colors in the "black light" of invisible ultraviolet rays, Mr. Millson explained.

The absolute darkness necessary to bring out the full beauty of modern motion pictures in color has increased the chance of accident to people entering theaters from brightly lighted foyers, Mr. Millson said, and to overcome this carpets can now be had dyed with fluorescent dyes to light the way in total darkness. Instead of the usual shaded lights along the aisles of theaters (which interfere with the fidelity of colored pictures and generally illuminate only the area near the light), small electric tubes shed ultra-violet rays on the carpet which is normal in all respects except that the dyes used to color it possess the property of fluorescence. This same effect is utilized in modern fluorescent tube lamps which yield light with a minimum of heat. The exact nature of fluorescence is not completely understood, but apparently when ultraviolet rays are absorbed by fluorescent materials, these substances radiate soft visible light. This property, possessed by quinine sulfate, certain dyes, certain minerals and numerous other substances, has been utilized in the past for many purposes including identification of minerals, the examination of questioned documents, the fluoroscopic screens which make x-rays visible, and the viewing screens of television.

The present patented application of fluorescent dyes as guides in the dark is expected to have important uses in many other fields.

• MAYNE NAMED ASSISTANT MANAGER

The United States Testing Company has just announced the designation of S. C. Mayne, Jr., as Assistant Manager of its Southern Testing House at 1200 Arlington Street, Greensboro, N. C.

Mr. Mayne originally came from Georgia but has been in the main Hoboken laboratories of the Testing Company since his graduation from Clemson College as a textile engineer. He will service the Southern accounts of the Testing Company, working under S. J. Gillie, manager of the Greensboro branch.

Studying Fulling Phenomena—

(Continued from page 390)

Using these values of S_{10} and S_{20} we could calculate K_m from the relation

$$K_m = \frac{S_{10} + S_{20}}{20}$$

This is approximately equal to the instantaneous rate of shrinkage K_s if S_{10} and S_{20} are small. Using eequation (1) we can easily show that

$$K_s = 0.0576\ [2 \log (1\text{-}S_{10}) + \log (1\text{-}S'_{20})]\ldots(6)$$

where $S'_{20} = S_{10} + S_{20}$.

This equation is cumbersome to use so a plot has been made of K_s against S'_{20}. It is plotted in Figure 2 using several different ratios of S_{10} to S_{20}. Using this it is possible to get fairly accurate values of K_s from the data with very little work.

A study has beeen made of errors in the above procedure. In the course of our investigation we have compared yarns treated with various oxidizing agents, alkalies, acids, etc. at various temperatures and shaken in baths of various compositions and temperatures. These data were worked up to obtain the probable error for a given value of K_s. Figure 3 is a plot of probable error in K_s against K_s. It must be understood that this relation, unlike that of equation (6), holds only for the particular batch of yarn which we are using or the particular shaking device we use. Such a curve is of value in interpreting the data obtained, that is in deciding what the effect of a given treatment has on the rate of yarn shrinkage K_s.

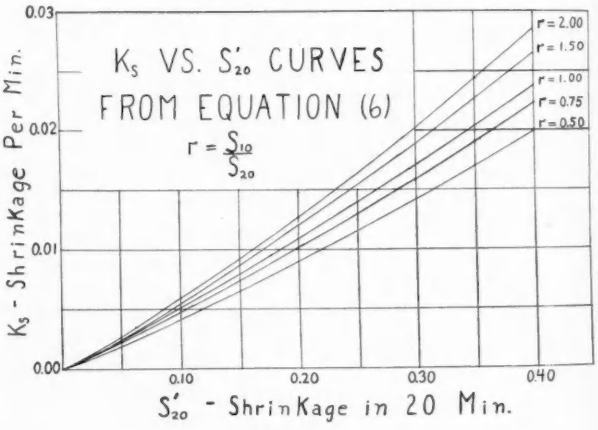


Figure 2.

All this might be made a little clearer by giving an example. We will study briefly the effect of aqueous solutions of sodium hypochlorite on shrinkage of wool yarn. The yarn was soaked in a bath of sodium hypochlorite solution of known strength for 30 minutes. The ratio

TABLE 5
A Study of Shrinkages of Sodium Hypochlorite Treated Woolen Yarn

	Temperature of Sodium Hypochlorite Bath					
	20° C.			60° C.		
Per cent NaClO in bath	0.05	0.10	0.50	0.05	0.10	0.50
L_0 cms.	90.4	91.6	92.8	91.6	91.0	91.2
L_{10} cms.	85.4	87.6	92.8	84.9	88.6	90.7
L_{20} cms.	80.3	83.5	92.3	80.4	85.6	89.6
S_{10}	0.055	0.044	0.000	0.073	0.026	0.005
S_{20}	0.056	0.045	0.0053	0.049	0.033	0.012
S'_{20}	0.111	0.089	0.0053	0.122	0.059	0.017
$r = \frac{S_{10}}{S_{20}}$	0.98	0.98	0.00	1.49	0.79	0.42
K_s	0.0056	0.0045	0.0002	0.0070	0.0027	0.0007
Probable error of K_s	0.0004	0.0005	0.0002	0.0005	0.0004	0.0002

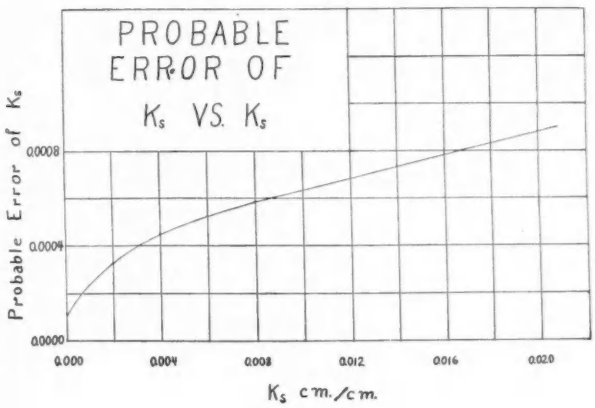


Figure 3.

of weight of wool to bath was 1:50. Three strengths of sodium hypochlorite were used; 0.05 per cent, 0.10 per cent and 0.50 per cent. Two different temperatures were tried; 20°, and 60° C. The calculations are best followed by reference to Table 5. The results show almost perfect unshrinkability obtained from a bath of 0.50 per cent sodium hypochlorite. The effect of temperature of the treatment is slight and in favor of the lower temperature.

Although the laboratory method of measuring yarn shrinkage is quite different from the commercial processes of fulling and felting, it still seems to us that the processes show many points of similarity. We feel that conclusions reached by the yarn shrinkage method will be at least in qualitative agreement with commercial process experiments. Thus, yarns may be treated with sodium carbonate and shrink 40 per cent of their initial length after shaking for 20 minutes in 1 per cent sulfuric acid. The same type of yarn might also be treated with sodium hypochlorite and shrink only 0.5% under similar conditions and untreated yarn would shrink 14.5 per cent. We feel that qualitatively the same results would be obtained if wools given similar sodium carbonate or sodium hypochlorite treatments were processed by ordinary fulling or felting methods, at least during the initial stages of the process.

ACKNOWLEDGMENT

We acknowledge the helpful criticism of J. A. Levering of Eavenson & Levering Co. and of H. Boeddinghaus of the American Felt Co.

REFERENCES

[1]Schofield, J.: J. Textile Inst., Vol. 29, page T239 (1938).
[2]Speakman, J. B., Stott, E., and Chang, H.: J. Textile Inst., Vol. 24, page T273 (1933).

• OPEN FORUM •

Rules under which this department of the REPORTER is conducted are as follows:

1. Anyone who has a technical problem on which he would like advice may submit it to the Reporter and it will be published in the first available issue.

2. Any reader who feels that he has a solution of the problem may forward his reply to us and if we feel that the reply is suitable it will be published in a succeeding issue.

3. For each such reply published the Reporter will pay a minimum of $2.

4. In case there is more than one answer to the same question, the one covering the subject in the most complete and authentic manner will be published, or if two answers are sufficiently different both will be published. If two answers are considered equally good, the one first received will be given priority.

5. The Reporter will assume no responsibility whatsoever for the accuracy of the answers submitted—it is simply offering a vehicle for the public expression of its readers' opinions.

6. Both the questioner and answerer must send in his complete name and address. When requested we will publish only the initials or other identifying insignia.

51—Raw silk, during the last few years, has been coming through with considerable exfoliation, known to the trade as "lousiness" and looks like little white flecks on the thread which do not take the dye, and therefore, gives the thread a hairy or fuzzy appearance.

We would like to know of a way to clean the thread of such imperfections.—**L. B. B.**

Answer—We believe that the following explanation of the causes of the exfoliation, while it does not tell how to clean the thread of the imperfection, should be of interest to L. B. B. and the readers of the Reporter.

In order to give an explanation of the causes of certain exfoliations of silk, which is known to the industry as "lousiness," it will be necessary to begin at the beginning and describe the origin of the silk fiber, and to tell what conditions in the formation of the silk are involved, bringing about the undesirable fuzzy appearance.

The silkworm has two silk glands that contain a liquid secretion, and also has two smaller glands whose function is not quite clear, but it is thought that the formation of the silk is a biological reaction that is similar to the clotting of blood. It is well known that fresh blood when drawn from an artery and placed in a perfectly clean test tube will show no tendency to form a blood clot unless combined with a small amount of lymph from the cells of the skin. It is the assumption that the secretions from the small glands work as a sort of a precipitant of the secretions of the larger glands of the silkworm at the same time that it is ejected from the glands through the spinnerets. The precipitating causes one element to take a dense fibrous structure, leaving the rest to precipitate just a few seconds later, and to thus act as a binding material. It can be seen that if we are to obtain a perfect silk fiber the reaction that takes place must be accomplished under the most favorable conditions. Just as in the case of the human body, if there should be a condition where there is an apparent deficiency of calcium, one of the first symptoms is the failure of the blood to clot, so it is to be supposed that if there is a deficiency of any of the essential mineral ingredients that bring about the formation of the silk, this can result in producing a defective fiber.

The silk filament is constructed roughly in the shape of double parallel fibers of rounded triangular cross-section known as the fibroin, and cemented together with a glue-like substance called the sericin. The action of the degumming agents removes not only the sericin, but seems to penetrate the fiber, and if there is not a uniformity of structure, the fibrillae, of which the fiber is made up, will be separated, and the additional processing action will cause the ends to break and produce the exfoliation.

It is hardly possible that any means can be devised to remove these broken ends from the fiber, since they are a part of the silk, but there are available to the industry certain protective colloids, known as protein decomposition products, which can be added to the different processing baths, and which minimize both the action of the alkalies and the prolonged boiling. Raw silk, even though the utmost care and precautions are taken, is subjected to a certain amount of friction in processing, and this friction is commonly known as chafing, resulting in broken fibrillae that show up as white streaks after the fabric has been dyed. The use of one of the higher sulfonated fatty alcohols acts as an efficient lubricant and can be incorporated with a protective colloid to give very satisfactory results towards helping to reduce to a certain extent the exfoliations.

It is only natural that the dyer should receive the blame for this trouble, for the reason that it is very easy to assume that he has overworked the silk in processing, but an investigation of the raw silk by making the various tests for cohesion and boiling off, together with the practical dyeing tests can help to throw some light as to where the blame should be placed.—**Harry White.**

Question

52—We are dyeing and finishing gabardines containing 15 per cent wool and 85 per cent rayon in the warp, while the filling is 100 per cent cotton and have considerable trouble with streaky shades warp wise on the face when dyed in tan shades.

It is possible that some of the readers of the OPEN FORUM may have suggestions regarding this difficulty.—**T.M.A.**

• CLASSIFIED ADVERTISEMENTS •

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i.e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

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